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Human Experience in Regulated Offices Extended (HEROx) protocol

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We are still developing and optimizing this protocol

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Abstract

This protocol describes a Human Experience in Regulated Offices Extended (**HEROx**) experiment protocol conducted during a winter-season experimental campaign with 26 adult participants. The study investigates multimodal physiological, behavioral, and environmental responses during ecologically valid office-like activities under two controlled thermal conditions: a Lower Temperature (LT) condition and a Higher Temperature (HT) condition. Each participant were observed in both HT|LT session.

The session is organized into four structured experimental blocks to ensure reproducibility and phase-resolved signal alignment. **Block 0 (Foundational State)** includes acclimation and baseline resting phases to establish thermophysiological reference states. **Block 1 (Individual Activity)** consists of reading and structured text production tasks (typing and handwriting), separated by washout intervals. **Block 2 (Collaborative Activity)** includes a guided discussion task to capture socially interactive cognitive engagement. **Block 3 (Disruptive Activity)** incorporates posture transition (stand-up) and simulated phone/report tasks to induce behavioral and attentional perturbations.

Across all blocks, a fixed 15-phase timeline with standardized washout periods enables precise segmentation of multimodal recordings. Task order counterbalancing preserves phase alignment while minimizing order effects. Continuous synchronized recording ensures reproducible phase marking suitable for high-resolution analysis of environmental stress modulation and recovery dynamics.

Guidelines

Study Design

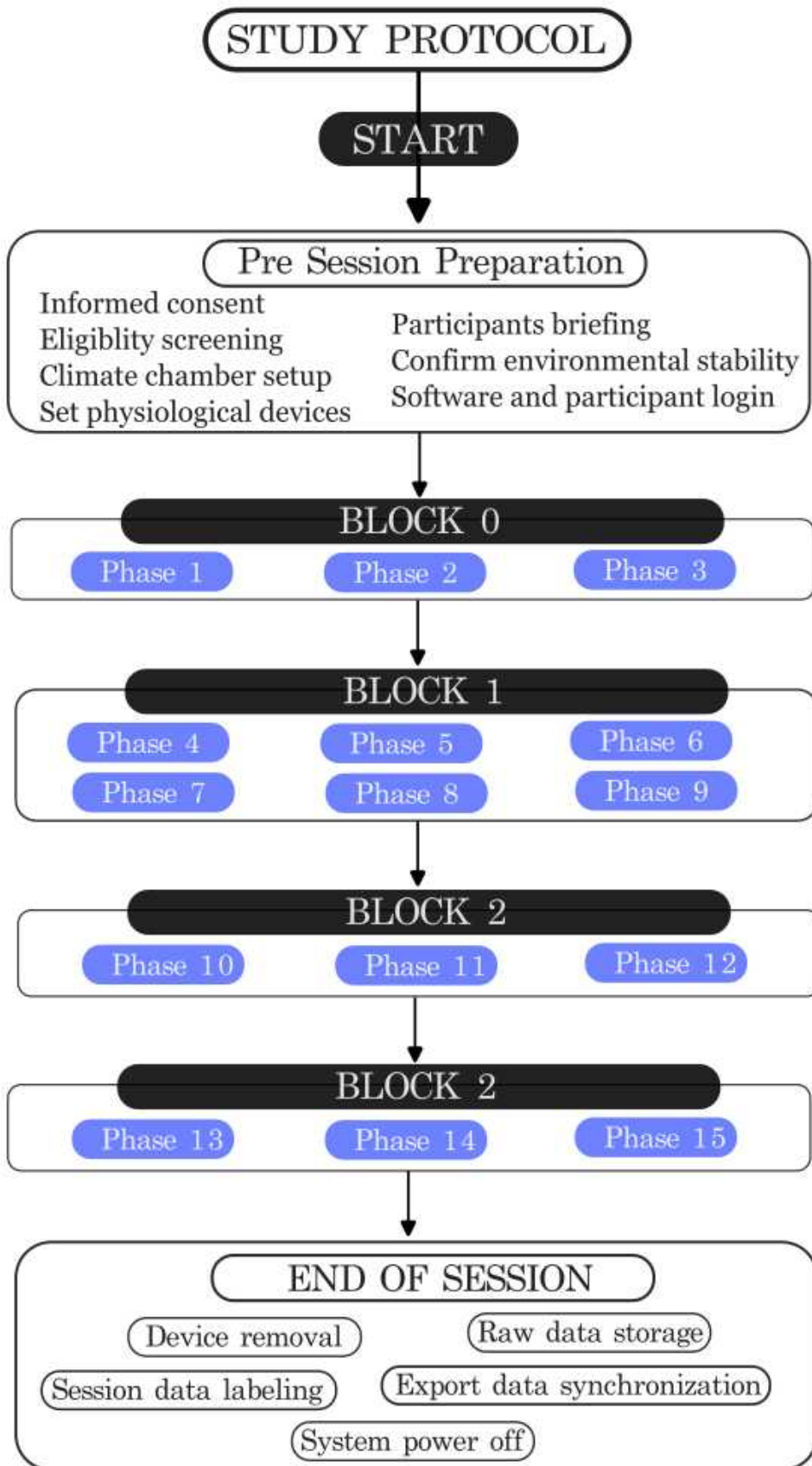


Figure 1. **Experimental session flow diagram.** Sequential overview of Blocks 0–3 (Phases 1–15), illustrating phase-resolved sequence.

The experimental campaign included 26 adult participants tested under controlled indoor climate conditions during the winter season. Each participant completed a full structured session consisting of 15 predefined phases grouped into four hierarchical blocks.

Two thermal exposure conditions were implemented in two different sessions:

- Lower Temperature (LT) condition
- Higher Temperature (HT) condition

Thermal condition assignment was controlled at the session level. Within-session task order for paired tasks (typing/writing and phone/report) was counterbalanced while maintaining fixed phase indices for alignment consistency.

The structured phase design enables phase-resolved comparison across thermal conditions and task categories (resting, individual cognitive activity, collaborative interaction, and disruptive/postural transitions).

Experimental Setting

All sessions were conducted in a controlled indoor climate chamber NEXT.ROOM during the winter experimental campaign. Environmental parameters were continuously monitored throughout each session. Two indoor thermal exposure conditions were implemented: **Lower Temperature (LT)**: Target indoor air temperature centered around 18–19 °C. **Higher Temperature (HT)**: Target indoor air temperature centered around 27–28 °C.

Observed air temperature (mean ± standard deviation) during the campaign:

- LT condition: **18.60 ± 1.13 °C**
- HT condition: **27.72 ± 0.58 °C**

Temperature stability was maintained throughout each session. Environmental data were recorded continuously to ensure traceability and reproducibility. Participants remained inside the chamber for the full duration of the approximately 62–72 minute per session.



Materials

Participant Materials

- Reading text (standardized across sessions)
- Writing task prompt sheet
- Typing task instructions
- Discussion prompt sheet
- Phone call script
- Report preparation instructions

Data Collection Materials

- Physiological recording devices (e.g., EDA, EEG, temperature sensors)
- Environmental sensors (temperature, humidity, CO₂ if applicable)
- Computer workstation
- Desk and adjustable chair
- Timing control software (master timeline system)

Before start

- Obtain informed consent.
- Screen participant for eligibility.
- Prepare the climate chamber and validate sensors, including software and hardware.
- Fit physiological monitoring devices and confirm signal quality.
- Brief participant about task flow without revealing research hypotheses.
- Confirm environmental stability.
- Load master timeline file for session.

Safety and Ethics

- Participants may withdraw at any time.
- Monitor for thermal discomfort.
- Stop the session if the participant reports adverse symptoms.
- Ensure compliance with institutional ethical approval requirements.



Experimental Procedure

1h 2m

1 BLOCK 0

20m

Phase 1 — Acclimation

Duration: 20 minutes

- Participant remains seated quietly to acclimate to environmental conditions.
- No cognitive tasks are performed.
- Minimal interaction from experimenter.
- Initial questionnaire (S_I) responses

2 BLOCK 0

1m 30s

Phase 2 — Baseline (Resting)

Duration: 1.5 minutes

- Participant sits quietly, eyes open, neutral posture.
- No speaking, reading, or device interaction.
- Baseline physiological signals recorded.

3 BLOCK 0

3m

Phase 3 — Washout 1

Duration: 3 minutes

- Neutral recovery period following baseline.
- Participant remains seated.
- Baseline perception (S_B) questionnaire

4 BLOCK 1

5m

Phase 4 — Reading Task

Duration: 5 minutes

- Activity individual
- Participant reads standardized text silently.
- No note-taking allowed.

5 BLOCK 1

3m

Phase 5 — Washout 2

Duration: 3 minutes



- Neutral seated recovery period.
- Post activity perception-survey (S_A) questionnaire.

6 BLOCK 1

5m

Phase 6 — Typing or Writing Task (First Task)

Duration: 5 minutes

Participant performs the first task of the pair:

- Activity individual
- Either typing (computer-based text production)
- Or handwriting (pen-and-paper writing task)

The order of typing and writing is counterbalanced across sessions.

7 BLOCK 1

2m

Phase 7 — Washout 3

Duration: 2 minutes

- Neutral recovery period.
- Post activity perception-survey (S_A) questionnaire.

8 BLOCK 1

5m

Phase 8 — Typing or Writing Task (Second Task)

Duration: 5 minutes

Participant performs the remaining task (whichever was not performed in Phase 6).

- Activity individual

9 BLOCK 1

2m

Phase 9 — Washout 4

Duration: 2 minutes

- Neutral recovery.
- Post activity perception-survey (S_A) questionnaire.

10 BLOCK 2

1m 30s

Phase 10 — Stand-Up Task

Duration: 1.5 minutes



- Participant stands upright beside workstation.
- No walking permitted unless specified.
- This phase is used to capture postural and cardiovascular shift effects.

11 BLOCK 2

5m

Phase 11 — Discussion Task

Duration: 5 minutes

- Activity: Collaborative
- Structured discussion between participant and experimenter using standardized prompts.
- Ensure conversational engagement remains task-focused.

12 BLOCK 2

2m

Phase 12 — Washout 5

Duration: 2 minutes

- Seated recovery period.
- Post activity perception-survey (S_A) questionnaire.

13 BLOCK 3

2m 30s

Phase 13 — Phone Call or Report Task (First Task)

Duration: 2.5 minutes

Participant performs first of the pair:

- Activity: Disruptive
- Simulated phone call interaction
- Verbal or written report generation

Note: The order is counterbalanced across participants or sessions.

14 BLOCK 3

2m 30s

Phase 14 — Phone Call or Report Task (Second Task)

Duration: 2.5 minutes

- Activity: Disruptive
- Participant performs remaining task.

Note: The order is counterbalanced across participants or sessions.

15 BLOCK 3

2m

Phase 15 — Final Washout

Duration: 2 minutes

- Final seated neutral recovery period prior to device removal.
- Post activity perception-survey (S_A) questionnaire.

Timing Summary

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Phase	Duration (minutes)
Acclimation	20
Baseline	1.5
Washouts (total)	~14
Active task time	~30
Total session time	~65 minutes

Data Management

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- Store raw data immediately after session completion.
- Label files using the standardized session ID format (e.g., $P\{ID\}_D\{Day\}S\{A,B\}\{LT|HT\}$).
- Export synchronized timeline file.
- Maintain an anonymized dataset structure.

Anticipated Results

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- Phase-aligned multimodal physiological data
- Task-specific behavioral signatures
- Thermal condition comparative data
- Recovery dynamics across washout periods

The structured alternation between cognitive load, social interaction, posture change, and neutral recovery enables phase-resolved analysis of environmental stress modulation on human performance.

Protocol references

Tomar, P., Ago, D., Pigliautile, I., Cosoli, G., Martins Gnecco, V., Casaccia, S., Gianluca, G., Mansi, S. A., Pisello, A. L., & Arnesano, M. (2025). Human Experience in Regulated Offices Extended (HEROx) dataset [Data set]. Zenodo. <https://doi.org/10.5281/zenodo.17141776>

Tomar, P., & Pisello, A. L. (2026). Physiological-perceptual divergence (PPD) in human thermal adaptation: Multimodal evidence of decoupled body-mind responses during controlled indoor exposure. *Building and Environment*, 292, 114256. <https://doi.org/10.1016/j.buildenv.2026.114256>

Tomar, P., Ago, D., Pigliautile, I., Martins Gnecco, V., Cosoli, G., Casaccia, S., Sartini, G., Mansi, S. A., Pisello, A. L., & Arnesano, M. (2025). Human Experience in Regulated Offices (HERO) dataset [Data set]. Zenodo. <https://doi.org/10.5281/zenodo.17957768>

Vittori, F., Chiatti, C., Pigliautile, I. & Pisello, A. L. The NEXT.ROOM: Design principles and systems trials of a novel test room aimed at deepening our knowledge on human comfort. *Building and Environment*, 211, 108744 (2022). doi:[10.1016/j.buildenv.2021.108744](https://doi.org/10.1016/j.buildenv.2021.108744)

EL kounni, A., Tomar, P., Vellei, M., Le Dréau, J., PISELLO, A. L., Inard, C., & Ramallo-González, A. (2026). ChronoLight Thermophysiology Response (CLTR) Dataset [Data set]. Zenodo. <https://doi.org/10.5281/zenodo.18270221>

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